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POTENTIAL IMPACT OF ICRP-30 ON THE CALCULATED RISK FROM WASTE REPOSITORIES

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During the past decade, the measure of toxicity of many radioactive materials has been based on the amount of water required to dilute the waste radioactivity to a value specified by federal regulations as being acceptable for release to the general public. This water volume (toxicity) has generally been determined by dividing the curies of each nuclide by its Radionuclide Concentration Guide (RCG) value given in 10 CFR 20[1] (Ci/m^3 H_2O) and then summing over all nuclides. The RCG values given in 10 CFR 20 for the general public were based principally on the results of ICRP-2,[2] which provides similar values for occupational situations and defines the methods used to calculate them.

As a result of the large body of information that has been gathered since ICRP-2 was published (1959), the ICRP has undertaken the task of updating its radiation protection guidance. This update involves revision of the primary radiation guidance[3] as well as the recalculation of intake limits (ICRP-30)[4] based on updated biological models, updated nuclide decay schemes, and a new method accounting for simultaneous dose to more than one organ.

A detailed analysis of the impacts of ICRP-30 on waste repository safety and risk analyses would require an extensive and detailed study that has not yet been undertaken. Nevertheless, it is possible to identify, in an approximate manner, the impact of using ICRP-30 instead of 10 CFR 20/ICRP-2 in calculating the risk from radioactive repositories. Toward this end, the numerical guidance of ICRP-30 has been obtained[4,5] and converted into RCG values for the general public using the same methods that were employed in deriving 10 CFR 20. A more detailed discussion of the differences between 10 CFR 20 and ICRP-30 is given in ref. 6. The conversion was cross-checked by comparing 10 CFR 20 and ICRP-30-based

values that were known to have remained the same. The most restrictive ICRP-30 RCGs were incorporated into the ORIGEN2 computer code,[7] which was then used to calculate the toxicity of some radioactive materials of interest in waste repository considerations.

As a basis for discussion, the toxicities of the spent fuel from a PWR and of the uranium ore required to make the fuel are given in Fig. 1 for both the 10 CFR 20 and ICRP-30-based RCGs. As is evident, the use of the revised RCGs reduces the toxicity of the spent fuel at times less than 100 years and increases the toxicity at times thereafter. The principal reason for the short-term reduction in the total toxicity is that the toxicity of ^{90}Sr has been reduced by a factor of 13 and that of its daughter ^{90}Y by a factor of 3. The other short-lived materials that contribute significantly to the total toxicity are virtually unchanged.

During the mid-term (100 to 10,000 years), the larger toxicity resulting from the ICRP-30 values is due solely to a 25-fold increase in the toxicity of ^{241}Am. Between 10,000 and 100,000 years the ICRP-30-based toxicity is greater because of sixfold increases in the toxicities of ^{239}Pu and ^{240}Pu. The ICRP-30-based toxicity is larger at times between 100,000 and 1,000,000 years, principally as a result of a 340-fold increase in the toxicity of ^{237}Np. The dominance of the ^{237}Np persists for very long times because of its 2-million-year half-life and the eightfold reduction in the toxicity of its principal competitor, ^{226}Ra.

The toxicity of uranium ore decreases by a factor of 1.6 when the ICRP-30-based RCGs are used, principally because of the decrease in the toxicity of ^{226}Ra. The time at which the toxicity of the spent fuel is equal to that of its parent ore is about 7000 years after fuel discharge if the 10 CFR 20 values are used and about 3 million years if the revised RCG values are employed. This change is principally due to the increased toxicity of ^{237}Np.

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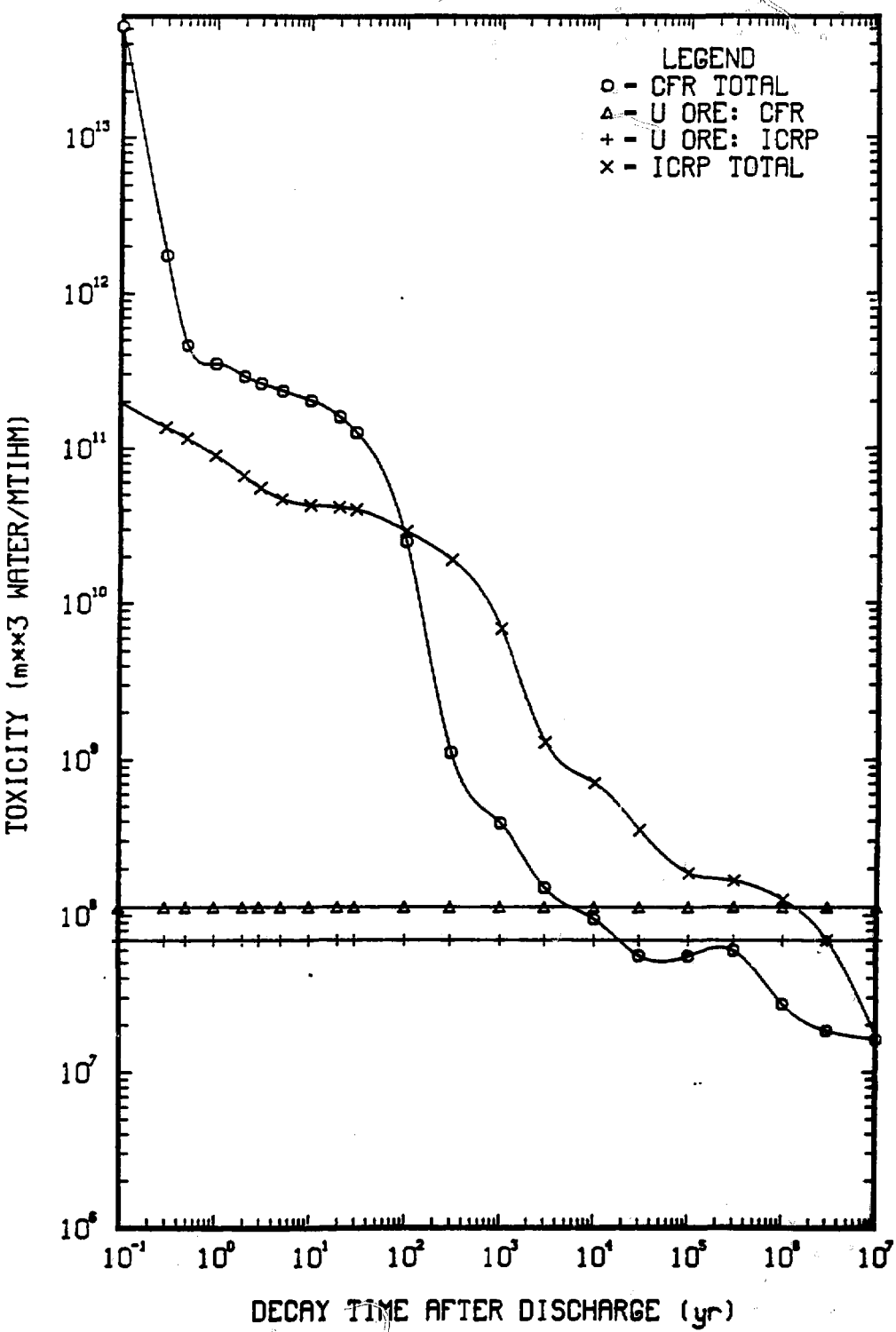

Fig. 1. Toxicity of PWR spent fuel and its parent uranium ore.

The change in the relative toxicities of spent fuel and its parent ore may have serious implications for current rulemaking activities (e.g., ref. 8), which have used this equivalence time in support of proposed regulations concerning the retention time of nuclides in a repository. The implications of the ICRP-30 work for more sophisticated waste repository risk calculations are also clear from this study. The contribution of ^{237}Np, which can migrate through the geosphere relatively quickly under some circumstances,[9,10] has been greatly increased, whereas the contribution of ^{226}Ra has been significantly decreased. In addition, the toxicities of ^{99}Tc and ^{129}I, which could contribute significantly to the risk in some repository situations,[9,10] have been reduced by factors of 2.5 and 11 respectively.

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